ALL-BAND FIELD ST

An FSM is the most reliable indicator that a CB or amateur station is really putting

IN THIS AGE OF DIGITAL GIZMOS AND WHATSITS THAT measure everything with an accuracy out to the umpteenth decimal place, the old-fashioned FSM (*F*ield-*S*trength *M*eter) is still the most-reliable indicator of RF energy for CB and amateur transmitters and antennas. The reason it's the most reliable indicator is because an FSM indicates *radiated RF energy*. It doesn't tell you anything about the standing-wave ratio, transmission-line losses, the transmitter's efficiency factor, or anything else other than how much relative RF energy is being sensed at the meter's location. If you can increase the amount of energy radiated from the antenna, the FSM's reading will similarly increase. If the energy leaving the antenna decreases, the FSM's reading will similarly decrease. If you're using a directional beam and you swing it around so that the FSM is now off the back of the antenna, the meter reading should decrease—or you have a **BIG problem** with your antenna.

If someone talks you into blowing a week's wages on a new kind of low-loss transmission line, and the FSM—at the reference location—indicates no, or very little change in field strength, figure you most likely would have been better off wasting the money on wine, women, and song.

Its Usefulness

Since an FSM is sensitive only to the relative amount of radiated RF, it's an ideal indicator for almost any kind of transmitter or antenna adjustment that affects how your rig gets out. For example, let's assume that you have purchased one of those new pocket-size, quick-mount mobile-CB antennas that claim to outperform any "full-length" antenna. If you just swap antennas, the best you can hope for is some good buddy saying something to the effect that your new signal *appears* to sound louder today than it did a few days ago. Since the ear is a notoriously poor judge of signal strength, and also because a receiver's AGC (*A*utomatic *G*ain *C*ontrol) will automatically equalize moderate to strong signals, a signal report from anyone receiving your signal when it's stronger than a flea's whisper is worthless.

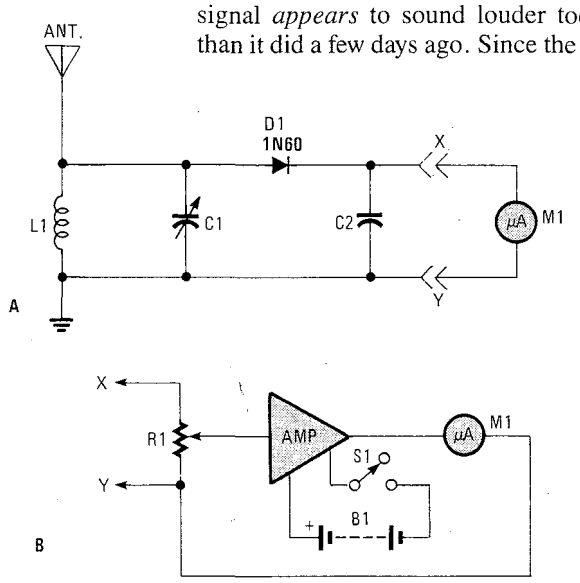


Fig. 1—The basic tuned FSM circuit is shown in 1A. The amplified meter in 1B sharply increases overall sensitivity.

On the other hand, look what an FSM will do for you. If it's a super-sensitive model, such as the one shown in the photographs, you set it up well out of range of the antenna's "shock field." (Say a quarter to a half a block away). You leave your old antenna on the Detroit Iron, key the transmitter, and note the meter reading. (Use binoculars if your vision isn't all that good, or have someone else read the meter.) Next, you install the new antenna and tune it; first following the supplied instructions on adjusting the antenna for lowest VSWR, and then tweaking the antenna tuning adjustment for the highest (strongest) reading on the FSM. If the new antenna is truly a better performer, the FSM's reading should be higher than it was for the old antenna. If it isn't, either you have done something wrong, or have made a poor choice (a nice way of saying you've been "taken").

You will most likely be surprised to discover that the lowest VSWR might not correspond to the highest FSM reading. Within reason, always go for the highest FSM reading when adjusting an antenna or tuning a transmitter: Low VSWR readings and minimum RF-output current don't necessarily guarantee maximum RF output. As long as the antenna and final-amplifier parameters are within their safe or rated range, use an FSM indicator when optimizing RF output.

Two Kinds

There are basically two kinds of field-strength meters: tunable and untunable. Both types are available in amplified and unamplified models. Both types have their advantages and disadvantages. The basic tunable FSM circuit is shown in

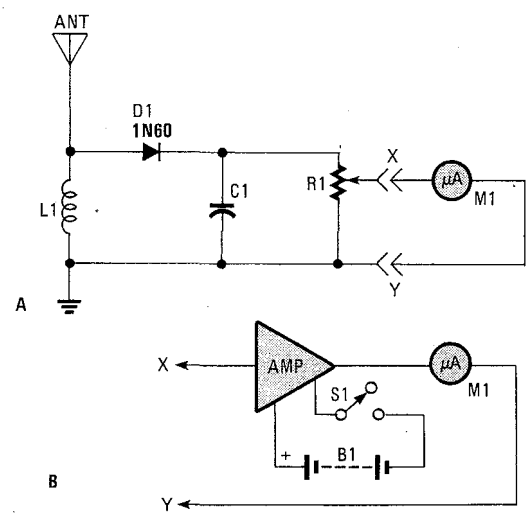


Fig. 2—An untuned field-strength meter is shown in 2A. An amplified version of the meter module is shown in 2B.

RENGTH METER

out the soup!

By Herb Friedman

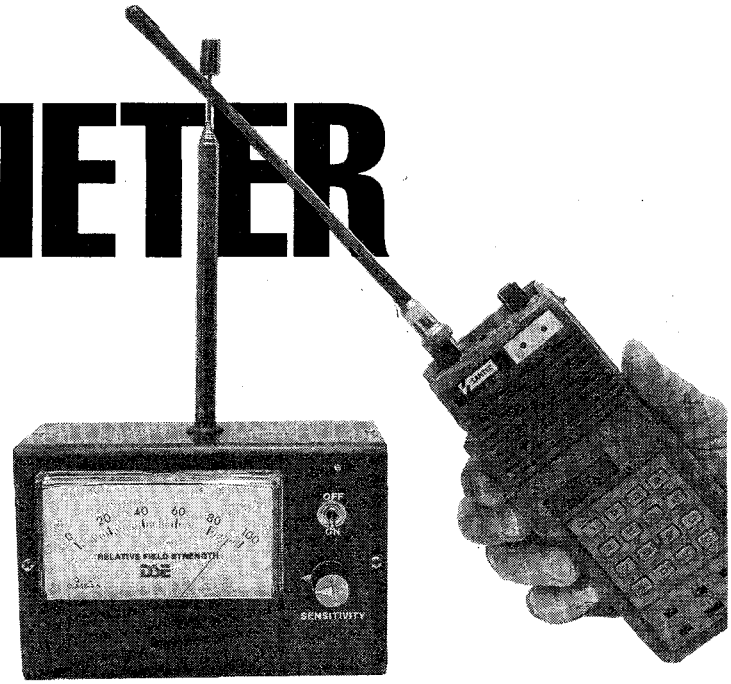


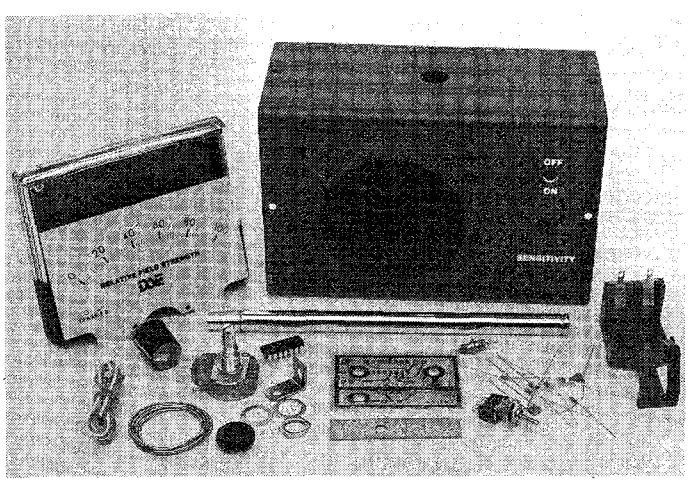
Fig. 1A. Coil L1 and variable capacitor C1 comprise a tuned circuit at the operating frequency of the transmitter or RF source. Naturally, a high voltage (at extremely low current) is developed across L1-C1. The RF voltage is rectified by D1—which should be a germanium diode such as the 1N60 because its breakover voltage is less than that of a silicon diode. The RF is filtered by C2, a small capacitor whose value is usually .001 μF below 30 MHz, or 100 pF from 30 MHz to 148 MHz. The resultant DC appearing across C2, which is proportional to the amount of RF received by the antenna, is indicated by meter M1.

If the signal is so strong that the meter pointer is "pinned," the sensitivity can be reduced by detuning C1. Unfortunately, in order to get any decent amount of sensitivity, meter M1 must be a 0–50 μA or a 0–100 μA model, both of which are rather expensive.

It's often much less expensive to use the circuit shown in Fig. 1B—a DC amplifier driving a less sensitive 0–200 μA or a 0–500 μA meter. The amplified meter is connected at the points labeled X and Y. The amplifier usually makes the overall sensitivity so great that tuning-control C1's adjustment becomes excessively critical, and literally breathing on its shaft will "pin" the meter. Instead, we use R1 as a "volume" control for the amplifier. It provides a broad range of adjustment.

Untuned FSM

A basic untuned FSM is shown in Fig. 2A. Essentially, the tuned circuit has been replaced by L1, an RF choke. (It's also possible to use a 10,000- or 20,000-ohm resistor instead of L1.) As you might imagine, the RF voltage developed across the choke is considerably less than that developed across a tuned circuit, so meter M1 must be extremely sensitive: 0-50 μA is almost a universal value. But even with so sensitive a



The Field-Strength Meter Kit is an old-fashioned type. Nothing is pre-assembled. Even the meter's special pre-calibrated scale must be installed by the builder.

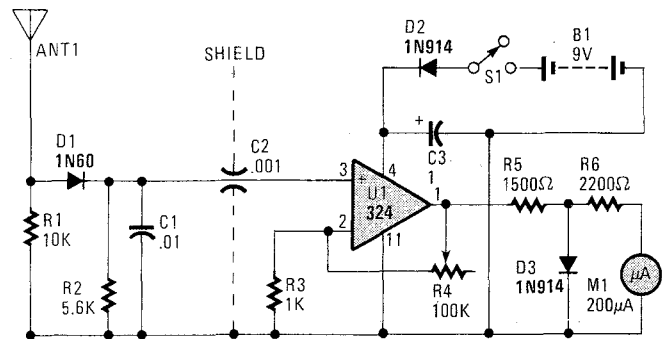


Fig. 3—This is the untuned, super-sensitive FSM. Capacitor C2 can be a conventional axial-lead ceramic capacitor instead of the feed-through type used in the circuit.

PARTS LIST FOR THE ALL-BAND FIELD-STRENGTH METER

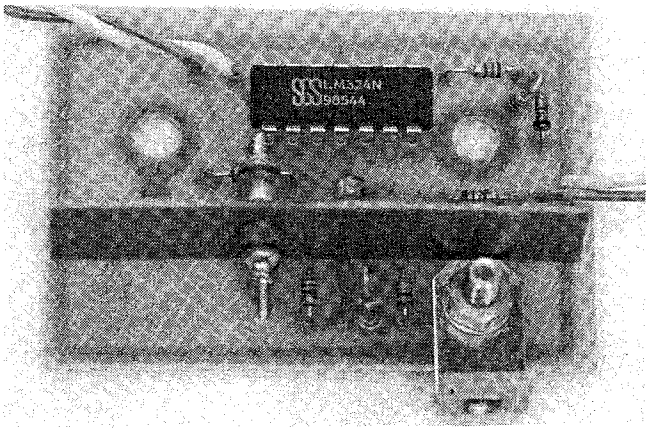
SEMICONDUCTORS
D1—1N60 germanium diode
D2, D3—1N914 silicon diode
U1—LM324 quad op-amp, integrated-circuit

CAPACITORS
(All capacitors rated 16-WVDC minimum.)
C1—0.01-μF ceramic disc
C2—0.001-μF feed-through, see text
C3—1-μF, Tantalum

RESISTORS
(All fixed resistors are ⅛-watt, 10% units.)
R1—10,000-ohm
R2—560-ohm
R3—1000-ohm
R4—100,000-ohm trimmer, audio, or liner potentiometer
R5—1500-ohm
R6—2200-ohm

ADDITIONAL PARTS AND MATERIALS
ANT1—Telescopic antenna
B1—9-volt battery
M1—200-μA DC meter
S1—SPST switch
Cabinet, wire, solder, printed circuit materials.
A complete kit of parts except for B1 (order #K-6321) is available for $39.95 from Dick Smith Electronics, PO Box 8021 Redwood City, CA 94063. Phone 800/332-5373 for details and shipping information. Please allow 6-8 weeks for delivery.

1989 PE HOBBYISTS HANDBOOK



This is the completed printed-circuit assembly. The metal L-bracket at the lower right is the mounting for the telescopic antenna. It is secured to the board with a screw.

meter—the overall sensitivity is low, and the FSM is best used with relatively powerful RF sources.

Still, not having to tune the FSM is advantageous, so what's often done is to substitute an amplified meter, as shown in Fig. 2B, for the "barefoot" meter.

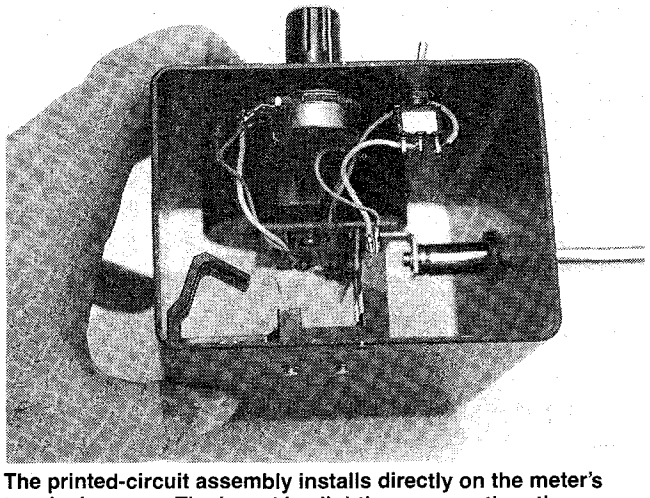
Notice that the Fig. 2B amplifier circuit is very similar to the one shown in Fig. 1B. The difference is R1. In Fig. 1B, it's part of the add-on amplifier. In Fig. 2B, the potentiometer is a part of the basic meter circuit.

Our Circuit

For most applications, the untuned but amplified FSM is the best choice because it has high gain, yet covers a broad range of frequencies without the need for plug-in or band-switched tuning coils. In fact, with a good amplifier design such as the one shown in Fig. 3, the FSM can almost sense that mythical flea's whisper—from 3 through 148 MHz no less—and yet, it is so immune to overload that, the meter pointer won't pin.

The key to the circuit is the amplifier, a type 324 quad op-amp, of which only one section is used. Why are we wasting three sections? Because, A) the 334 is cheap and easy to get; B) it's designed for a single-ended power supply (one, not two batteries); C) it will provide at least 20-dB DC gain; D) its output current is self-limiting—the pointer can't be pinned.

The photographs show an all-band FSM that uses the circuit shown in Fig. 3. Other than using the specified integrated circuit (U1) and providing a small shield to separate the RF detector from the amplifier, just about anything goes in the way of parts and assembly. However, a large, sensitive meter, a metal cabinet, and a good-quality telescopic antenna will probably cost you more than the same project in kit form from Dick Smith Electronics, so we'll describe the assembly of Dick Smith's Model K-6321 Field Strength Meter. If you want to homebrew your own FSM simply use our circuit and photos as a guide. But you'll have to make your own printed-circuit board.



The printed-circuit assembly installs directly on the meter's terminal screws. The board is slightly narrower than the meter; it can slip through the meter opening in the cabinet.

Construction

The kit comes completely knocked down; even the meter's scale and its mounting hardware are separate. The first step is to install the scale and put the meter aside; which sounds easier than it is because the clear faceplate doesn't snap off. (It's supposed to snap off, but ours didn't.) Very carefully, work a thin knife blade between the face and the meter's body dead center on the top edge. Rock the blade carefully—so you don't break the face. When you feel the face suddenly "give," it's loose. You can then remove the face, install the scale, and then snap the face back into position.

Next, assemble the printed-circuit board. It contains both the RF detector and the amplifier, and it mounts directly on the meter's terminals.

First, install a small shield across the length of the board, as shown. It's really a small strip of copper-clad board with a hole for feed-through capacitor C2. Small pins connect the copper foil of the shield through the top of the main board to the ground traces on the foil side. The feed-through capacitor must be soldered, as shown, to the shield. But if you're going to homebrew all the way and can't locate a feed-through capacitor, simply substitute an axial-lead ceramic type. Slip a short length of sleeving over one lead and pass that lead through the hole in the shield.

As shown in the photos, install the remaining board components, as well as a small metal L-bracket that will support the antenna. Connect the wires for sensitivity control R4 and for power switch S1 to the board, and then install the board on the meter's terminals. Make certain the board is installed so that the connections to the meter are the correct polarity. If the meter was supplied with a thin shorting wire across its terminals, be sure to remove the wire before installing the board.

Install the battery holder inside the cabinet, then slip the meter assembly into position. But before securing the meter, pass the antenna through a grommeted hole in the top of the cabinet and attach the bottom of the antenna to the L-bracket. Only when you have completely secured the antenna should the meter's mounting nuts be tightened. Then complete the remainder of the wiring to the panel-mounted components.

Meter Use

No adjustments are needed. Simply set power switch S1 to OFF, install the battery in its holder, and the meter is ready for you to use.

When you want to indicate the relative value of RF from an antenna, simply pull out the telescopic antenna, set S1 to ON, and advance R4 until you attain a convenient meter reading. Don't worry about a sudden increase in RF pinning the meter. Although the meter can read right up to the top of the scale, and perhaps even ease against the pointer's stop pin, it won't slam into the pin and damage the pointer, or knock the pointer's driving coil off its bearing. ■